Dr. Grandinetti

Chemistry 121
Fall Quarter 2007
Quiz 4

Monday
Oct. 29, 2007

Name KEY

Rec. Instr. ______________________

Two-Digit Section No. ______________________

Lab. Instr. ______________________

1. [7 points] The work done when a gas is expanded in a cylinder is -199 J. A heat transfer of 170 J occurs from the surrounding to the gas. Calculate ΔU of the gas in Joules.

$$w = -199\,J$$
$$q = +170\,J$$
$$\Delta U = q + w = 170 - 199 = -29 \text{ Joules}$$

2. [7 points] A system receives 50 J of electrical energy and delivers 150 J of pressure-volume work against the surroundings while gaining 300 J of heat energy. What is the change in the internal energy of the system?

$$\Delta U = \underbrace{+50\,J}_{\text{electrical work}} \underbrace{- 150\,J}_{p\Delta V \text{ work}} + \underbrace{300\,J}_{\text{heat}} = 200 \text{ Joules}$$

3. [7 points] A system undergoes a process in which $\Delta U = -300$ J while gaining 100 J of heat energy and undergoing an expansion against 1.0 atm. What is the change in the volume (L)?

$$\Delta U = q - p\Delta V = -300\,J = +100 - p\Delta V$$
$$p\Delta V = 400\,J \times \left(\frac{1 \text{ L-atm}}{101.325\,J}\right) = 3.9477 \text{ L-atm}$$
$$\Delta V = (3.9477 \text{ L-atm})/(1.0 \text{ atm}) = \underline{3.9 \text{ Liters}}$$

4. [9 points] When 375 J of heat is added to 35.0 g of benzene, C_6H_6, the temperature increases by 6.18°C. Calculate the molar heat capacity of benzene (J/mole−°C). (Atomic weights: C = 12.01 g/mole, H = 1.008 g/mole).

$$q = n C_p \Delta T$$
$$C_p = \frac{q}{n\Delta T} = \underbrace{375\,J}_{q} \underbrace{\frac{1}{35.0\,g} \cdot \frac{78.108\,g}{\text{mole } C_6H_6}}_{1/n} \underbrace{\frac{1}{6.18°C}}_{1/\Delta T}$$
$$C_p = 135 \text{ J/mole-°C}$$

Dr. Grandinetti

Chemistry 121
Fall Quarter 2007
Quiz 4

Wednesday
Oct. 31, 2007

Name KEY

Rec. Instr. ______

Two-Digit Section No. ______

Lab. Instr. ______

1. [7 points] A system generates 50 J of electrical energy and delivers 150 J of pressure-volume work against the surroundings while releasing 300 J of heat energy. What is the change in the internal energy of the system?

$$\Delta U = \underbrace{-50\,J}_{\text{electrical work}} \underbrace{-150\,J}_{p\Delta V \text{ work}} \underbrace{-300\,J}_{\text{heat}} = -500\,J$$

2. [7 points] Determine which of the following reactions at constant pressure represent systems in which work is done on the system by the surrounding environment.

   (a) $2\,CO(g) + O_2(g) \longrightarrow 2\,CO_2(g)$

   (b) $2\,H_2O_2(l) + N_2H_4(l) \longrightarrow N_2(g) + 4\,H_2O(g)$

   (c) $N_2(g) + O_2(g) \longrightarrow 2\,NO(g)$

3. [7 points] A system undergoes a process in which $\Delta U = -300$ J while releasing 100 J of heat energy and undergoing an expansion against 0.5 atm. What is the change in the volume (L)?

$$\Delta U = q - p\Delta V = -300\,J = -100 - p\Delta V$$

$$p\Delta V = 200\,J \times \left(\frac{1\text{ L-atm}}{101.325\,J}\right) = 1.97385\text{ L-atm}$$

$$\Delta V = (1.97385\text{ L-atm})/(0.5\text{ atm}) = 3.9\text{ liters}$$

4. [9 points] How much heat energy (kJ) must be supplied to heat 200.0 g of linseed oil from 20.0°C to 50.0°C in a copper vessel weighing 500.0 g. The specific heat of linseed oil and copper are 1.84 J/g−°C and 0.38 J/g−°C respectively.

$$q = m_{cu} C_s^{cu} \Delta T + m_{oil} C_s^{oil} \Delta T$$

$$q = (500.0g)(0.38\,J/g\text{-}^\circ C)(30.0^\circ C) + (200.0g)(1.84\,J/g\text{-}^\circ C)(30.0^\circ C)$$

$$q = 5{,}700\,J + 11{,}040\,J = 16{,}740\,J$$

$$\boxed{q = 1.67 \times 10^4\,J}$$

Dr. Grandinetti

Chemistry 121
Fall Quarter 2007
Quiz 4

Friday
Nov. 2, 2007

Name ______________________ Rec. Instr. ______________________

Two-Digit Section No. ______________________ Lab. Instr. ______________________

1. [7 points] A system receives 50 J of electrical energy and delivers 150 J of pressure-volume work against the surroundings while releasing 300 J of heat energy. What is the change in the internal energy of the system?

$$\Delta U = \underbrace{+50\,J}_{\text{electrical work}} - \underbrace{150\,J}_{p\Delta V \text{ work}} - \underbrace{300\,J}_{\text{heat}} = -400\,J$$

2. [7 points] The work done when a gas is compressed in a cylinder is 199 J. A heat transfer of 270 J occurs from the gas to the surroundings. Calculate ΔU of the gas in J.

$$\Delta U = q + w = q - p\Delta V = -270\,J + 199\,J$$

$$\boxed{\Delta U = -71\,J}$$

3. [6 points] Determine which of the following reactions at constant pressure represent systems that do work on the surrounding environment.

(a) $NH_4NO_3(s) \longrightarrow N_2O(g) + 2\,H_2O(g)$
(b) $U(s) + 3\,F_2(g) \longrightarrow UF_6(s)$
(c) $PCl_3(l) + Cl_2(g) \longrightarrow PCl_5(s)$

4. [10 points] A sheet of 10.0 g of gold at 18.0°C is placed on a 20.0 g sheet of iron at 55.5°C. What is the final temperature of the two metals assuming that no heat is lost to the surroundings. The specific heats of gold and iron are 0.129 J/g−°C and 0.444 J/g−°C respectively.

$$q_{Au} + q_{Fe} = m_{Au} C_s^{Au} \Delta T_{Au} + m_{Fe} C_s^{Fe} \Delta T_{Fe} = 0$$

$$(m_{Au} C_s^{Au} + m_{Fe} C_s^{Fe}) T_f = m_{Au} C_s^{Au} T_i^{Au} + m_{Fe} C_s^{Fe} T_i^{Fe}$$

$$T_f = \frac{m_{Au} C_s^{Au} T_i^{Au} + m_{Fe} C_s^{Fe} T_i^{Fe}}{m_{Au} C_s^{Au} + m_{Fe} C_s^{Fe}}$$

$$T_F = \frac{(10.0g)(0.129 J/g\text{-}°C)(18.0°C) + (20.0g)(0.444 J/g\text{-}°C)(55.5°C)}{(10.0g)(0.129 J/g\text{-}°C) + (20.0g)(0.444 J/g\text{-}°C)}$$

$$T_F = 516.06\,J / 10.17\,J/°C = 50.7434°C \approx \boxed{50.7°C}$$